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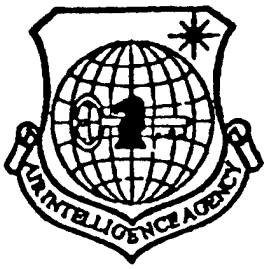

EXPENDABLE ELECTRONIC WARFARE

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EXPENDABLE ELECTRONIC WARFARE

Liang Baichuan

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ABSTRACT This article discusses two types of important content in the designs of expendable electronic warfare systems--loads and methods of release. It is believed that foil strips are the ultimate means of jamming to handle radar homing missiles.

KEY WORDS Infrared jamming Expendable electronic warfare +Loads +Release method

Since British forces released 40t of foil strips on Hamburg 24-25 July 1943, the prelude was begun to expendable electronic warfare. As far as this instance of release is concerned, it saturated and confused German forces radar. In conjunction with this, the price was low, achieving success in the Hamburg air raid. In more than half a century, expendable electronic warfare has already become a very complicated branch in the realm of electronic warfare--turning into a key condition for the achieving of victory in modern war.

BASIC CONCEPTS

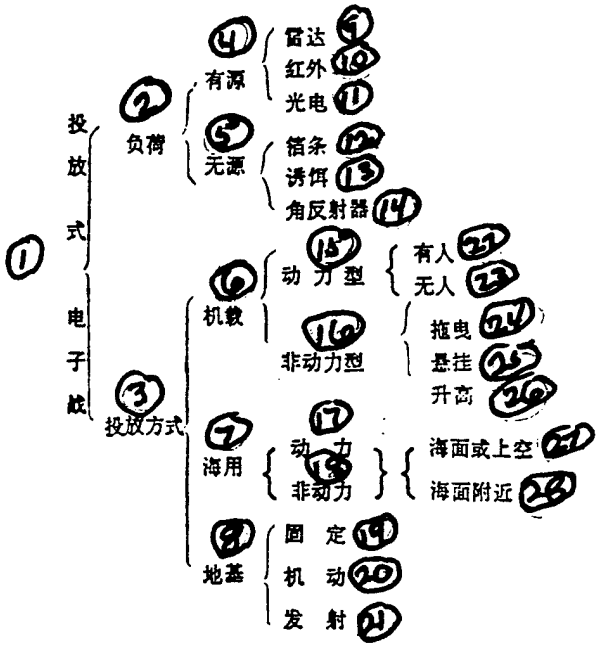

Fig.1 Expendable Electronic Warfare Classifications

Key: (1) Expendable Electronic Warfare (2) Load (3) Method of Release (4) Active (5) Passive (6) Airborne (7) Maritime (8) Ground Based (9) Radar (10) Infrared (11) Photoelectric (12) Foil Strips (13) Decoys (14) Corner Reflectors (15) Powered Types (16) Nonpowered Types (17) Powered (18) Nonpowered (19) Fixed (20) Mobile (21) Launched (22) Manned (23) Unmanned (24) Towed (25) Suspended (26) Ascending (27) Sea Surface or Aerial (28) Vicinity of Sea Surface

"Expendable" comes from an English term. In the original language, it has two types of different meanings. The first type indicates a one time use. The second type means released. What we are discussing here as expendable electronic warfare refers to jamming objects that are used once and not recovered. Of course, it also includes such things as smoke screens, other concealing objects, as well as acoustic decoys, and so on.

Discussions of general methods associated with electromagnetic expendables have in mind two design requirements--loads and release methods. Classifications of expendable electronic warfare are as seen in Fig.1.

2 LOADS

a. Foil Strips

Foil strips are the earliest type of expendable countermeasure load. They are a type of thin and narrow metal strip or wire or metalized glass fibers used in reflecting electromagnetic waves. In concept, foil fibers are simple. However, optimization of jamming results with regard to the use of foil strips is still a question worthy of study. Due to the fact that, during the process of using foil strips, the variables (factors) involved reach as high as ten or fifteen, solving by analytic methods is extremely difficult. Therefore, the design methods associated with foil strip systems usually rely on experience or use wind tunnels, darkrooms, or actual flight experiments in order to make precise determinations. For example, these variables are:
- cross section areas of single foil strips or dipoles;
- cross section areas of jamming packages;
- cross section areas of jamming clouds or jamming corridors;
- flocculation (expendable foil strip dipoles all put together) as well as mixing effects; /46
- dispersion time;
- polarization effects;
- attenuation of jamming clouds;
- weight and shape factors in terms of structure and dimensions;
- forms of release;
- environment (wind, humidity, index of refraction, and so on);
- screening effects;
- drop speed.

Foil strips are a type of universal, inexpensive countermeasure equipment not only capable of protecting aircraft but also able protect equipment on the sea and on the ground. As far as the effects of airborne foil strips are concerned, it is possible to use foil strip irradiation methods to achieve intensification. Foil strips are most effective in the decoying of missiles in terminal guidance phase. The reason is that, generally, radars carried on missiles--at a given range--lock on to the strongest reflector. In conjunction with this, warheads are detonated. However, foil strips are not able to confuse ground radars and computers on missiles. If use is made of Doppler radar, differences in foil strip cloud and aircraft speeds are easily observed. Foil strip irradiation operating programs are for aircraft to make use of precision radiation source positioning technologies or to utilize other intelligence to specify the locations of radars. After that, pilots change course. At the same time, use is made of signals associated with electronic countermeasure nacelles to irradiate foil strips. Nacelles emit a certain frequency and modulation, producing Doppler frequency shifts analogous to aircraft continuing along the original flight

course. In this way, foil strip clouds which are observed by radar, seem to be moving at the speed of aircraft.

Modern expendable device loads are not limited to foil strips. They may also lead infrared radiation missiles guided toward aircraft engines. Since the infrared missiles used during the 1950's, infrared missiles have already become the primary weapon producing aircraft losses. Among infrared rounds, the ones used the most are tracer rounds.

b. Tracer Rounds

Ordinary tracer rounds possess comparatively high benefit cost ratios with regard to first generation heat seeking ground to air and air to air missiles. The wave lengths associated with early infrared missile guidance heads were within the short infrared spectrum wave band (1-3μm). This corresponds to spectra associated with engine exhaust gas temperatures that are 300-2000K. First generation tracer rounds make use of what is called "hot brick" magnesium powder.

Hot engines produce easily observable characteristics. In order to counter the attacks of infrared missiles, cooling is carried out before and after tail gases are discharged into the atmosphere. This then requires that guidance head sensors be sensitive to relatively long wave lengths. Because of this, research was done on such special material detectors as mercury cadmium zinc, CaAs, platinum silicate, and so on to replace early lead sulfide and lead telluride detectors.

Following along with the appearance of second and third generation infrared missile guidance heads, requirements for decoys are even higher. These new models of missiles will not be fooled by simple tracer rounds. The reason is that, on these missiles, spectral sensors are capable of disntinguishing between tracer rounds and real targets. This then requires that tracer round spectra be closer to target radiation spectra. Because of this, one has the appearance of bright/dark tracer rounds.

Despite that fact that tracer round spectra are capable accurately simulating the platform they are protecting, smart guidance heads are also capable of using computers to analyze in real time momentum characteristics or motion characteristics associated with tracer rounds. As a result, at the present time, option is not made for the use of the early expendable types--that is, tracer rounds launched from aircraft to act as incandescent light sources. Option is, however, made for the use of "smart" tracer rounds. "Smart" tracer rounds opt for the use of aerodynamic designs. They are not only capable of displaying the real trajectories but their stable flight and lowering weakening effects given rise to by dropping wind flows.

One type of "smart" tracer round is called "Gemini". It is a type of infrared/RF decoy. The top portion of the round missile head is loaded with foil strips. The top of the missile body is loaded with folded parachutes, infrared tracer rounds, and the ignition apparatus. A few seconds after firing, Gemini produces very large radar cross sections. It produces, at the same time,

extremely intense infrared radiation.

As far as another type of infrared decoy round, called Hiram, is concerned, it is capable of being launched from standard warship guns. After firing and after it falls onto the sea surface, it deploys to become rubber rafts, holding up masts. The radiation associated with one Hiram infrared round is the equivalent of a large warship--producing, for missile infrared detectors, another attractive target.

c. Other Expendables

Thin pieces of foil and tracer rounds are not capable of representing the whole of expendable items. Active decoys are able to emit stronger radio frequency signals than target echoes. Because of the space interval between expendable items and main aircraft, strong signals are able to make missiles deflect from the aircraft. With regard to radio frequency decoys, there are the TI company's active radar decoy GEN-X. Its forward body is the main oscillation--amplifier type one time use response device POET. GEN-X makes use of single chip microwave/millimeter wave integrated circuits in order to lower costs and shrink dimensions. This type of decoy is a type of rocket round. Its radiation is similar to/or equivalent to aircraft echoes. /47

STRAP (straight through repeater antenna project) puts forward the development of a one time use aircraft external radio frequency decoy. It possesses wider frequency bands and larger powers in order to replace the POET and GEN-X decoys. Future decoys are capable of using new models of traveling wave tube amplifiers. These are a type of high speed activation, short life, thermal emiting cathode traveling wave tube. They are under development at the present time.

The advanced airborne decoy (AAED) is designated AN/ALE-50. It is used to decieve single pulse radar in order to lure away incoming missiles. What is under development at the present time are rocket propelled systems of decoys and towed types of decoys. Towed decoys are composed of launch control devices, launchers, and towed type false targets.

3 EXPENDABLES

Expendables are capable of being released by many types of methods. Early foil strip packets were released by hand from aircraft. Later, they were forcibly released by propelling devices. Electromagnetic expendables are capable of being released from various types of aircraft. They can also be released by such things as pilotless aircraft, parachutes, balloons, kites, and so on. They are also capable of being projected on both the surface of the sea and the ground. It is also possible for projected objects to be connected on tow cables and released later.

The majority of electromagnetic expendables all have projector systems for release. The projector systems are a type of gun or small arm barrel. The small arm barrels are composed of two parts--explosive detonator and round load. As far as countering radar is

concerned, option is made for use of propellant loads which include foil strips, infrared rounds, radio frequency rounds, as well as mixed loads, and so on. Going through ten or fifteen years of development, the Navy primarily opts for the use of AN/ALE-39B projection devices. They are capable of use in all Navy tactical aircraft. They are able to project foil strip rounds, infrared tracer rounds, RF jammers, as well as several tens of types of arbitrary combinations. The primary U.S. Air Force projection device is the AN/ALE-10. It is capable of projecting 170 foil strip rounds or 15 infrared tracer rounds. With slight structural changes, it is capable of being carried on various types of aircraft and does not have boundary surface joints. The AN/ALE-47 is an automatic projection system. It has three types of operating methods.

a. Automatic Sensor and flight parameters are inputed into computers. Selection is made of appropriate projection speeds, projection amounts, and other similar types of countermeasure responses. After that, countermeasures are initiated.

b. Semiautomatic First, in accordance with automatic methods, calculations and selections are made of appropriate countermeasure responses. After that, projection is started by air crew personnel.

c. Manual There are 6 types of countermeasure methods which are programable and, in conjunction with that, selected by cockpit pilot personnel.

The AN/ALE-47 will replace the AN/ALE-39 and the AN/ALE-10.

There is a type of "smart" projection device which is capable of having selections made of foil strip dipole length by electronic warfare operator personnel during flight--for example, the AN/ALE-43(V) foil strip cutting and projection system.

4 CONCLUSIONS

Expendable electronic warfare provides comparatively cheap protection for aircraft, warhsips, and ground vehicles to deal with autoguided (illegible) missiles and radar guided weapons. Speaking in terms of aircraft, the combining of evasive maneuver and the firing of infrared tracer rounds is the only self-protection measure to deal with missiles carrying infrared homing devices. Jammers are capable of making radar guided weapons malfunction. Moreover, foil strips are the ultimate jamming means of dealing with missiles that make use of radar homing.

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